Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

The
Journal of Infectious
Diseases

PUBLISHED BY THE MEMORIAL INSTITUTE FOR INFECTIOUS DISEASES

VOL. 17 *November, 1915* No. 3

A NEW MEMBER OF THE ACIDURIC GROUP OF BACILLI *

J. C. TORREY AND A. H. RAHE

From the Department of Experimental Pathology, Loomis Laboratory, Cornell University Medical College, New York City

A generally accepted characteristic of the bacilli grouped together as aciduric or acidophilic, such as the bacillus bulgaricus, the bacillus acidophilus, the Boas-Oppler bacillus and others, has been the absence of gas production when grown in sugar media. Recently one[1] of us noted, in the course of the routine isolation of aciduric bacilli from stools, that a very few produced gas. We further found that when human feces are planted into N/20 acetic acid glucose broth, in some instances there may be gas production without the presence of yeasts. Further investigation revealed the fact that the gas was formed by a bacillus of the same morphology, staining, and general biologic properties as the bacillus acidophilus. Since a careful search of the literature has not disclosed a description of a bacillus of this type, we have considered it a new species and have named it Bacillus acidophil-aerogenes.

To obtain some idea of the frequency with which this bacillus occurs in human feces, 38 specimens from 37 individuals were examined, of which the majority were from very young infants. The feces

---

* Received for publication June 18, 1915.

[1] Rahe: Jour. Infect. Dis., 1914, 15, p. 141.

of 9 individuals yielded this bacillus, of which 7 were adults and 2 infants, one of the latter being 8 days old and the other 6 months. Of 24 very young infants, ranging in age up to 19 days, in only one instance was the bacillus acidophilus found in the stool. On the other hand, a systematic examination of a few adult stools revealed its presence with only one exception. It seems probable that it occurs in the intestinal tract of most individuals and usually in much smaller numbers than does the non-gas-producing bacillus acidophilus of Moro.

This same aciduric gas-producing bacillus was also isolated readily from the feces of the sheep and the hen, but not from the few fecal specimens examined from dog, monkey, rabbit, guinea-pig, white rat, white mouse, goose, and pigeon. It is our belief, however, that this bacillus is widely distributed in nature and that an intensive search would reveal it in the intestinal tracts of a wide variety of animals.

In the isolation of this bacillus from the feces, a small amount of the material is seeded into +5.0 acetic acid glucose broth in fermentation tubes and incubated from 2 to 3 days. The tubes containing this gas-producing aciduric bacillus are then readily recognized. If the gas is due to yeasts, the fact will be indicated by the characteristic pellicle formation. This preliminary culture is then streaked on glucose oleate agar and several colonies are seeded again into the acetic acid broth, incubated for 2 days, and transferred to glucose broth tubes in which the natural acidity conferred by the meat has not been modified.

Either type of colony described by Mereschowsky for the bacillus acidophilus group may be produced by the bacilli of this type. That is to say, certain strains of this bacillus, when plated out on glucose oleate agar, formed small, round, white, opaque colonies about 1.2 mm. in diameter (Type 1), while other strains formed colonies that are gray, semi-transparent, smaller than a pinhead, with short, tooth-shaped projections (Type 2). After a few generations on oleate agar, this bacillus was induced to grow on glycerin agar of about +1.0 reaction and also on sugar-free agar of the same degree of acidity. The growth on these media was discrete and generally invisible before the second day. The colonies resembled those of streptococcus.

Altho, as a rule, as seen in fecal smears and on first isolation, the bacillus acidophilus is a slenderer rod than the bacillus bulgaricus, it exhibits a marked tendency to vary in morphology, and, after a few generations on artificial media, certain strains may assume a size and morphology which are identical with those of the bacillus bulgaricus. A typical strain of this gas-producing variety, grown 24 hours on unneutralized glucose broth, developed strongly gram-positive bacilli, in length from 1.50 to 11.50 microns and in width about 0.80 microns. Altho the greater number of the bacilli averaged about 5 microns in length, strings up to 40 microns were present in almost every field. With Loeffler's alkaline methylene blue, the bacilli stained evenly. On glycerin agar, the bacilli were thicker and longer than those grown in sugar broths or on oleate agar. Occasional Y-forms were to be seen, and the strings were frequent, long and curved.

These gas-producing aciduric bacilli grow vigorously in sugar broths of proper acidity and very characteristically. The type of the bacillus which does not produce gas tended to cloud the medium evenly and rather lightly, whereas the gas-producing type formed a growth showing a marked tendency to adhere to the bottom and the side of the tube; but, if the latter culture was shaken, the medium became as heavily clouded as in the case of the bacillus bulgaricus. Like the bacillus of Moro, this gas-producing type was not motile. As regards the rate of growth in fluid media, it was found that this gas-producing type multiplied much more rapidly than did the bacillus bulgaricus or the bacillus acidophilus (Moro). In unneutralized glucose broth, B. acidophil-aerogenes gave rise, 7 hours after seeding, to a distinct cloud of growth, whereas the control cultures of the bacillus bulgaricus and the bacillus acidophilus (Moro) showed no evidence of growth.

This bacillus was found to ferment actively, at 37 C., the following carbohydrates: maltose, saccharose, lactose, raffinose, and dextrose. For these tests, unneutralized, sugar-free broth was used as a base. No growth occurred in mannite or dextrin broths and none in any medium at room temperature. B. acidophil-aerogenes forms acid more actively on the average in sugar media than does the bacillus bulgaricus or the bacillus acidophilus (Moro). With 16 cultures of B. acidophil-aerogenes, grown for 3 days in unneutralized dextrose broth, the average percentage of normal acid was 10.0; whereas with 12 strains of the bacillus bulgaricus,[1] incubated for 5 days, it amounted to 5.61, for 21 strains of the bacillus acidophilus Group 2 (Rahe), to 5.66, and for 20 strains of the bacillus acidophilus, Group 3 (Rahe), to 5.09 The acid production of B. acidophil-aerogenes in terms of lactic acid is detailed in the following table.

TABLE 1

Acid Produced in 2% Glucose Broth in Terms of Lactic Acid (Incubation 72 Hours at 37 C.)

Jam.	0.945	Baby-3	1.125	C-5	0.720	Case-2	0.720
B-2	1.220	Baby-1	1.080	H	0.945	C-2	0.810
Ca-1	0.810	Buck	0.855	C-3	0.810	F	1.170
Be-9	0.855	Ca-3	0.855	Ca-4	0.720	C-6	0.765

The essential characteristic distinguishing this bacillus from the other hitherto described aciduric bacilli is the production of gas. This was produced, almost without exception, in broth containing any one of the five sugars mentioned. The amount of gas produced varied greatly for the several strains tested and even from time to time for a single strain. No increase in the amount of gas produced followed any increase in the amount of carbohydrate above 1%. Frequently an almost complete resorption of the gas occurred. After 72 hours' incubation, the maximal amount formed with any strain was 60% and the minimal 2%. For 16 cultures, the average amount formed in dextrose was 23%. The greater part of this gas was always hydrogen, the formula varying from 4H/1 CO_2 to 6H/1 CO_2.

Curiously enough, altho these gas-producing aciduric bacilli split lactose actively with a large production of acid, they grow poorly or not at all in milk. Only 1 strain clotted milk as early as 72 hours, while with 13 strains even partial clotting did not occur for from 15 to 20 days. Six cultures had no apparent effect upon the milk medium. The clot, when formed, was soft, with only a slight separation of whey. There were no gas streaks, even on continued incubation. In an effort to adapt these bacilli to a milk medium, several strains were replanted in this medium at 48-hour intervals for 5 weeks, but with no shortening in the time required to clot.

As is well known, the members of the aciduric group soon die out if kept at incubator temperature, on account of the increasing concentration of acid. In a comparative test, it was determined that a strain of the bacillus bulgaricus survived 6 days at 37 C. when growing in the glucose broth medium, while the bacillus acidophilus (Moro) lived for 15 days and B. acidophil-aerogenes for 8 days. At room temperature, however, B. acidophil-aerogenes survived much longer than did the other two types. At the end of 37 days, B. acidophil-aerogenes was still alive, whereas the bacillus acidophilus (Moro) had died out after 15 days and the bacillus bulgaricus after 6 days. At ice-box temperature, all the cultures were alive at the end of 50 days, altho the viable bacilli had decreased greatly. In the last two tests, the cultures were grown for 48 hours at 37 C., and then placed in the dark at the respective temperatures.

We have found that an agglutinating serum for the bacillus acidophilus may be produced without difficulty. Rabbits were inoculated intravenously with the growth from glycerin agar cultures. After 3 or 4 injections a titer as high as 1:800 was obtained. Of 14 strains of B. acidophil-aerogenes tested against a serum immune to one member of this gas-producing group, 10 gave positive agglutinations. On the other hand, none of several strains of the bacillus acidophilus of Moro reacted to this serum. Contrariwise, a serum immune to a strain of the bacillus acidophilus of Moro did not clump any of a number of strains of the gas-producing type. Further experiments of this character seemed to indicate that the gas-producing group of aciduric bacilli exhibited a higher degree of homogeneity than did the several strains conforming to the type of the bacillus acidophilus of Moro.